JET PROPULSION LABORATORY INTEROFFICE MEMORANDUM

February 22, 2005

TO: E. Burke

FROM: S. Guduru

SUBJECT: Mars Reconnaissance Orbiter Mission

REFERENCE: Mars Reconnaissance Orbiter **(MRO)** dated **10/28/2002**
Mars Reconnaissance Orbiter Mission 2005 Support Evaluation dated 11/12/2001
MRO_IOM_RARB_inputs_10-04.doc

The Resource Allocation Planning and Scheduling Office (RAPSO) performed an updated loading study to determine the impacts of Mars Reconnaissance Orbiter (MRO) prime mission tracking requirements on the Deep Space Network (DSN) and the ability to support those schedule requests.

Summary

Overall MRO is projected to receive greater than 90% of its requested time during prime mission. However, there are periods of high contention which will require significant negotiation to resolve.

In 2006 there are periods of contention, especially during the DSS-24 and DSS-45 scheduled maintenance downtimes. During these times MRO will have to negotiate with other Mars missions, MESSENGER (MSGR), Stereo Ahead (STA) and Behind (STB) to achieve its requested support.

In early 2007, limited view on the 34M stations at Goldstone (GDS) and Madrid (MAD) due to self-imposed 20-degree elevation mask constraints, force MRO to move its supports to the 70M subnet. This results in severe contention at the 70M, especially during New Horizon's (NHPC) Jupiter Flyby. MRO will need to maximize MSPA capability with Mars Odyssey (M01O) and negotiate with NHPC during this period. In 2008, there is contention with other Mars missions during Phoenix Relay Operations.

In 2009 and 2010, MRO shares nearly the same view period with Mars Telecommunication Orbiter 2009 (MTO) and Mars Science Laboratory (MSL) creating periods of significant contention. MRO can increase its supportability during these periods by agreeing to MSPA with MTO.

Assumptions

DSS-43 is down for antenna controller/hydrostatic bearing replacement in weeks 29-52 of 2005.
DSS-15 is down for antenna controller replacement in weeks 37-46 of 2005.
DSS-65 is down for antenna controller replacement and relocation in weeks 05-35 of 2005.
DSS-24 is down for X/X-Ka band replacement in weeks 36 - 42 of 2006.
DSS-45 is down for antenna controller replacement in weeks 41 - 49 of 2006.
DSS-63 is down for antenna controller replacement in weeks 21 - 35 of 2006.
DSS-54 is down for X/X-Ka band replacement in weeks 23 - 30 of 2007.
No downtime is planned for 2008-2010 at this time.
MRO launches on 08/10/05.
Venus Express launches on 10/26/05.
New Horizons launches on 01/11/06.
Stereo Ahead and Stereo Behind launch on 02/11/06.
DAWN launches on 06/17/06.
Kepler launches on 10/01/07.

Phoenix launches on 08/03/07.
The other major events/downtimes occurring during the study period are listed in the supporting data attached at the end of the study.

Methodology

Analysis was accomplished using the FASTER (Forecast And Scheduling Tool for Earth-based Resources) forecasting system with updated mission requirements for the February 2005 RARB (Resource Allocation Review Board) meeting. The following view period objects were used during the analysis: Network Support Subsystem MRO view period at Canberra for launch day, MRO forecast view period from launch to Mars Orbit Insertion (MOI); Mars 6-degree mask view period from MOI to Solar Conjunction in 2006, then again during Relay phase from November, 2008 to December 31, 2010; Mars 20-degree mask view period during the Prime Mission phase.

Requirements

Mars Reconnaissance Orbiter's prime mission requirements begin on August 10, 2005 and continue through Dec 31, 2010. The following study focuses on this period.

The requirements for the prime mission, along with the User Loading Profile (ULP) showing weekly requirements, Multiple Spacecraft per Aperture (MSPA) usage, and resource distribution are attached at the end of the study.

MRO should expect to receive above 90% of the requested time for most duration of the prime mission except in 2010 where the supportable percent falls below 85%. Since the study period spans for nearly four and a half years, it is divided into "phases" to get a closer look at the weekly averages over various subnets (70-meter and 34-meter).

Figure 1 shows the monthly supportable percentage of requested time forecasted for the duration of the study interval.

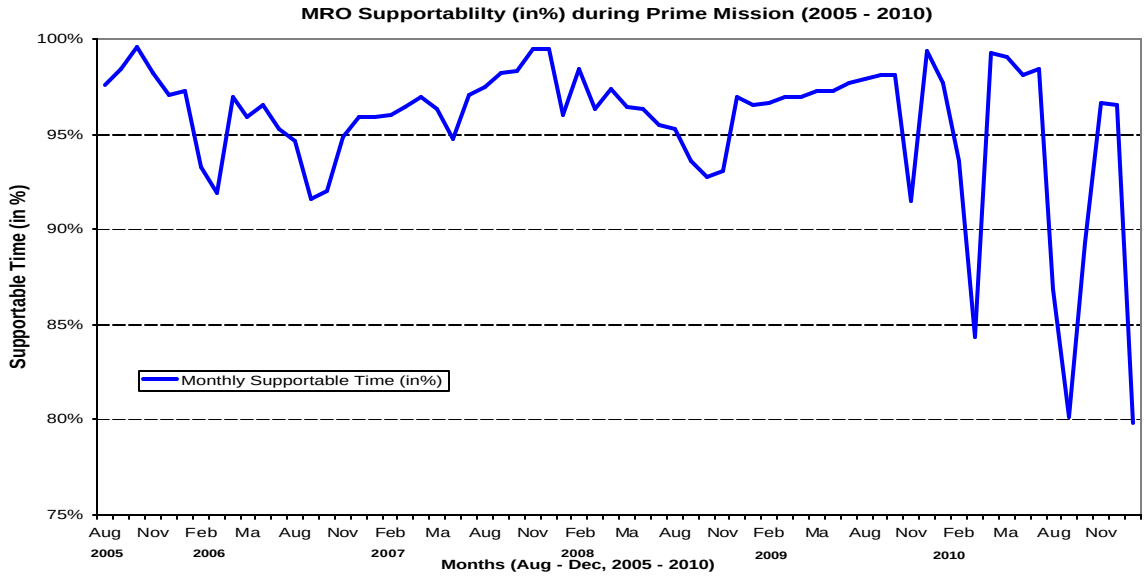


Figure 1

Launch and Cruise Phase

According to the supplemental MRO DSN Tracking Request Updates document received on 12th November 2004, the summary of the requested tracking support on Launch day is as follows:

Goldstone – DSS-15 plus one 34m station plus one 26m station (with acq aid)
Canberra – Two 34m stations plus one 26m station (with acq aid)
Continuous 34m coverage for the remainder of the day

The NSS view period is used at Canberra (CAN) for launch day (DOY 222) and is shown as "MROL" in Figure 2.

The current Mid-range schedule has the MRO launch day schedule as shown in the table below:

Mission	Antenna	SOA (Start of Allocation)	EOA (End of Allocation)	BOT (Track start)	Setup	Teardown	Track Hrs	Total Hrs
MRO	DSS-15	8/10/2005 9:20	19:35	13:20	4	0.25	6	10.25
MRO	DSS-16	9:20	19:55	13:20	4	0.25	6.3	10.55
MRO	DSS-26	9:20	19:35	13:20	4	0.25	6	10.25
MRO	DSS-34	9:20	20:00	13:20	4	0.25	6.4	10.65
MRO	DSS-45	9:20	20:00	13:20	4	0.25	6.4	10.65
MRO	DSS-46	9:20	20:35	13:20	4	0.25	7	11.25
MRO	DSS-54	8/10/2005 19:15	8/11/2005 8:55	20:15	1	0.25	12.4	13.65

Figure 2 also shows the view period overlap of MRO with other missions on the Launch day.

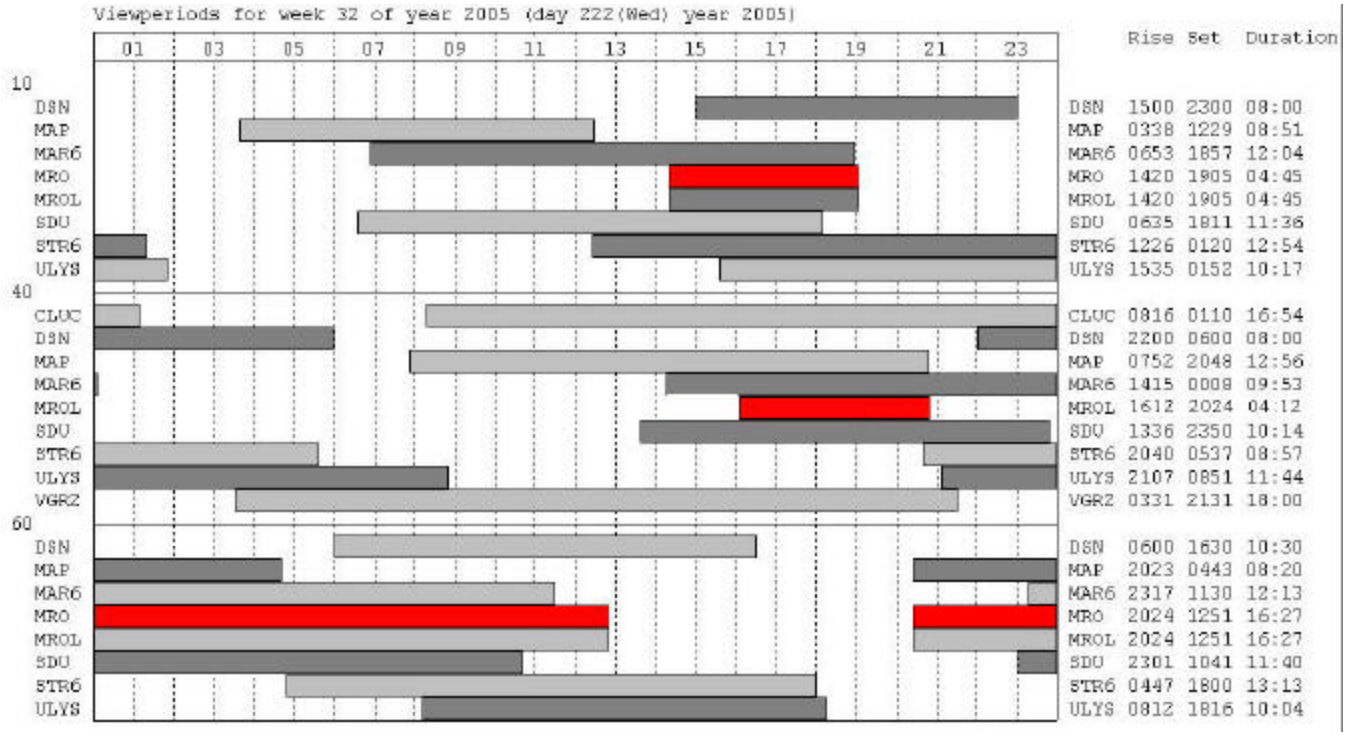


Figure 2

For Launch and Initial Acquisition, MRO is requesting all 34-meter antennas at CAN. This results in high contention with MER1, MER2, MGS and VGR2 on 34HEF subnet and MER1, MER2, IMAG and VGR2 on 34BWG1 subnet. MRO has nearly 100% view period overlap with MER1, MER2 and VGR2 and approximately 60% overlap with IMAG. During this period DSS-43 is down for maintenance, so these missions cannot be moved to DSS-43.

MER1, MER2 and MGS will have to MSPA with other Mars missions (M01O, MEX) at GDS and MAD on the 70M subnet to avoid contention with MRO. IMAG has contention at DSS-34 and will have to either move their support or delete their CAN support to allow MRO to get its requested coverage on DOY 222, 2005. VGR2 only has a southern view and hence a CAN antenna is essential for routine tracking. In order for MRO to get its requested coverage at CAN on the Launch day, VGR2 may have to reduce its pass duration to 5 hours.

Figure 3 shows the unsupportable time for the affected missions during MRO Launch and initial acquisition aid in week 32 on the 34HEF and 34BWG1 subnets.

Note: The mid-range scheduling process has begun to negotiate this time period.

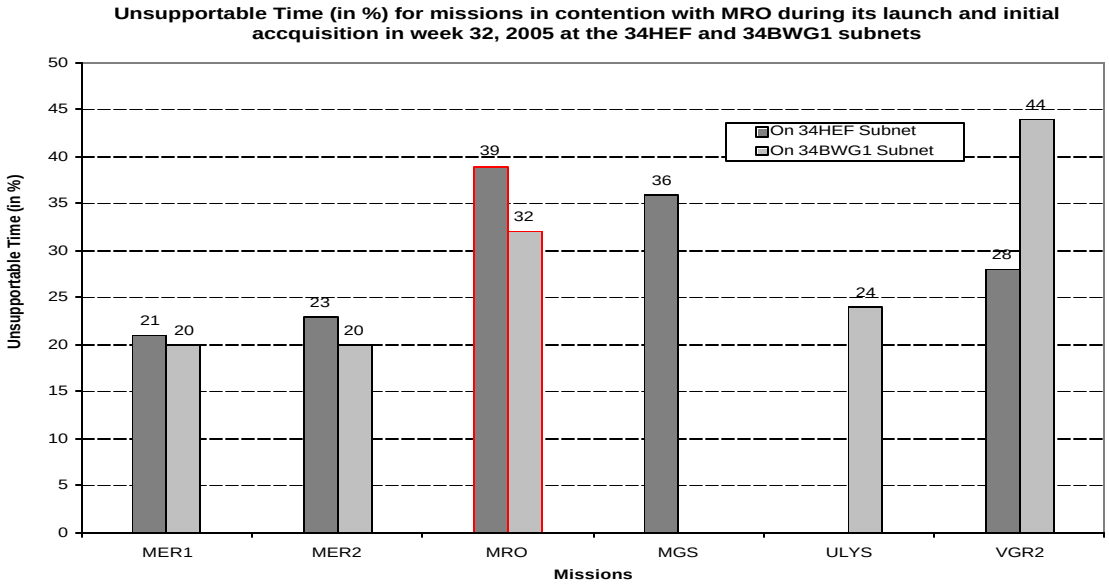


Figure 3

Except for the Launch and Initial Acquisition aid at Canberra on DOY 222, MRO is forecasted to receive 100% of the requested time during rest of the launch phase and about 90% of the requested time during Cruise phase.

Figure 4 shows the unsupportable percentage of time during the trajectory correction maneuvers (TCM). TCM-1 and TCM-2 occur during the Cruise phase and are more than 95% supportable. TCM-3, 4 and 5 occur during the Approach phase. TCM-3 is projected to lose 10% of the requested time on the 34BWG2 subnet in week 5 of 2006. Contention is mainly at DSS-55. MRO can increase its supportability during this week if it moves its support from DSS-55 to DSS-65. TCM-4 and TCM-5 are more than 95% supportable on the 34HEF subnet.

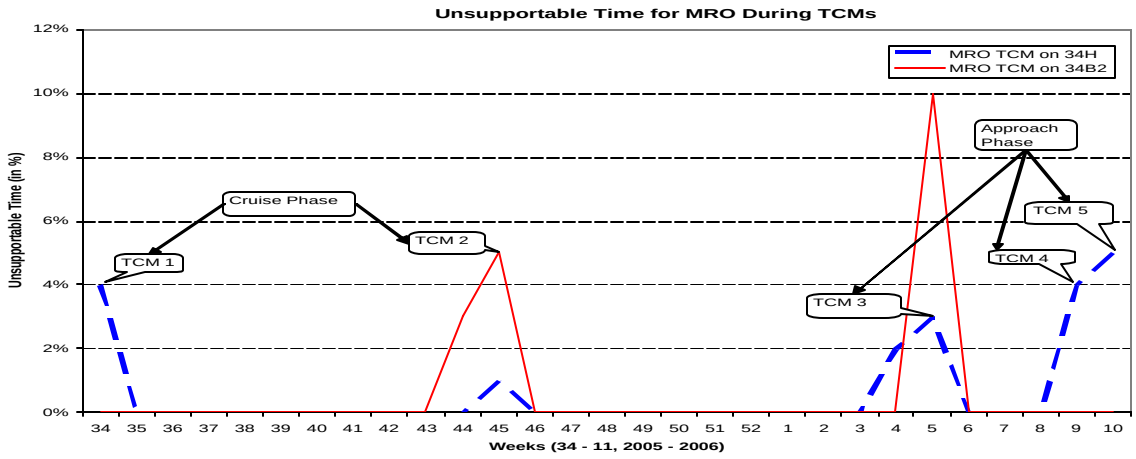


Figure 4

Approach Phase

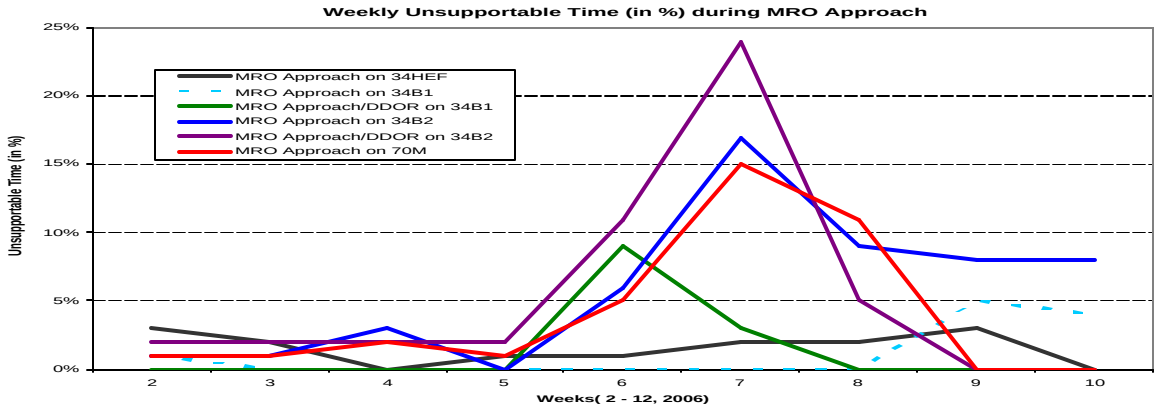


Figure 5

Figure 5 shows the unsupportable percentage of time for MRO during the approach phase. During this phase, MRO is above 90% supportable in all weeks except in week 7. The unsupportable time in week 7 is approximately 15% on the 70M subnet and is considered workable during mid-range scheduling. The unsupportable time on the 34BWG2 subnet ranges from 17 to 24%.

Week 7

Contention is at DSS-43 with requirements supporting 24-hour ATOT A01 Astrometry, Mars Odyssey (M01O) Mapping MSPA with Mars Global Surveyor (MGS) Mapping, MEX R/S Bistatic Test, Spitzer Space Telescope (STF), Ulysses (ULYS) and Voyager 2 (VGR2) routine support. Contention can be reduced if ATOT moves its 24-hour support from week 7 to week 5.

Contention at DSS-25 and DSS-55 is due to requirements supporting MSGR Cruise, MGS Mapping, MUSC TCM, SDU Post Earth Return, VEX Approach and Stereo Ahead (STA) launch, maneuver and phasing. Contention is primarily at DSS-55 and can be reduced if MRO moves some of its support from DSS-55 to DSS-65.The view periods overlap of MRO with the above missions at MAD during this week is shown in Figure 6. The view period for MRO is shown in red.

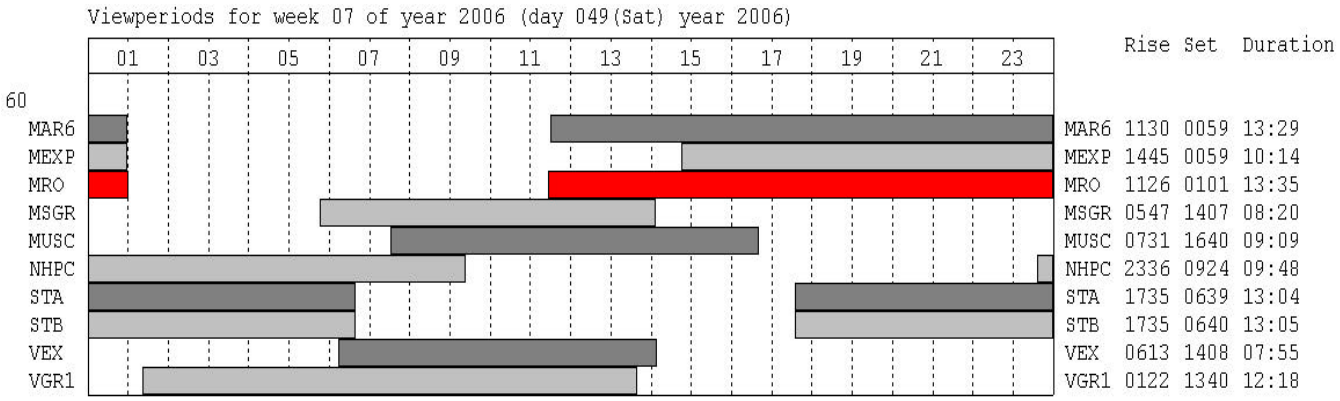


Figure 6 View Periods at MAD

Mars Orbit Insertion

MRO requests continuous support for MOI on the 70M in week 10 (DOY 069) and are only 53% supportable. It has contention with requirements supporting GSSR Asteroid 2000 PN9, CAS tour, EGS J-M4, GSSR Mercury Radar observations with Arceibo, GSSR Venus Radar Speckle Displacement (RSD) with Green Bank Telescope (GBT), M01O Mapping MSPA with MGS Mapping, MEX Orbital Science MSPA with M01O THEMIS, STF and ULYS routine support. In order for MRO to achieve 100% supportability during MOI, GSSR should avoid scheduling its activities at DSS-14 on DOY 069. M01O, MEX and MGS either have to reduce their supports at DSS-14,63 or move to 34-meter on this day to avoid contention with MRO.

The view period overlap of the above mentioned missions with MRO during this week is shown in Figure 7. MAR6 view is used for M01O, MEX and MGS missions and view period for MRO is shown in red.

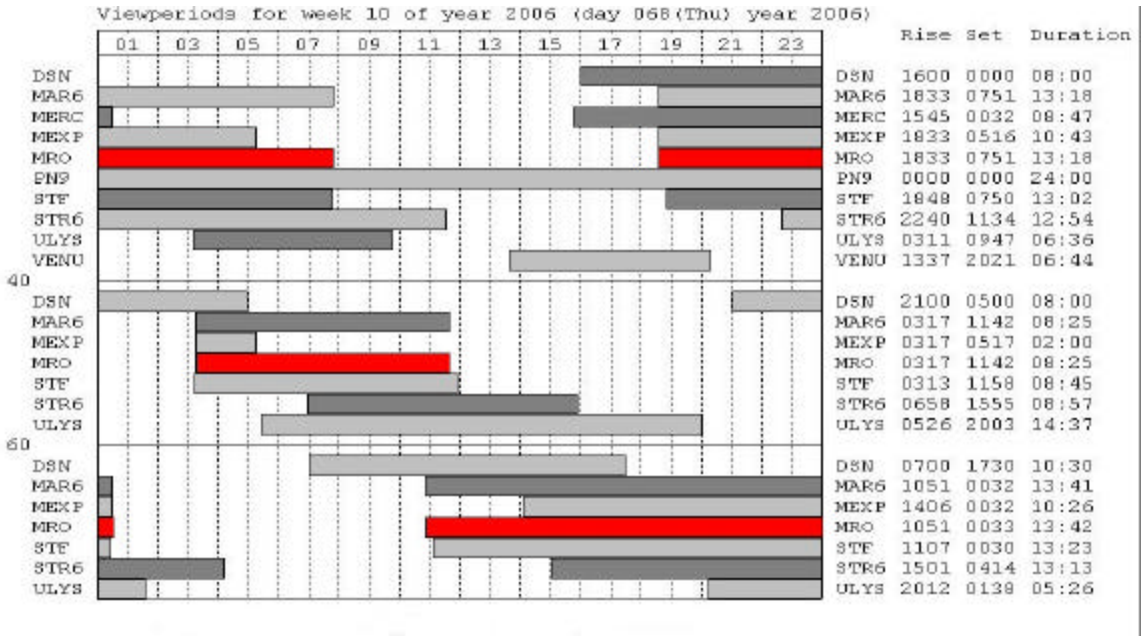


Figure 7

Aerobraking Phase

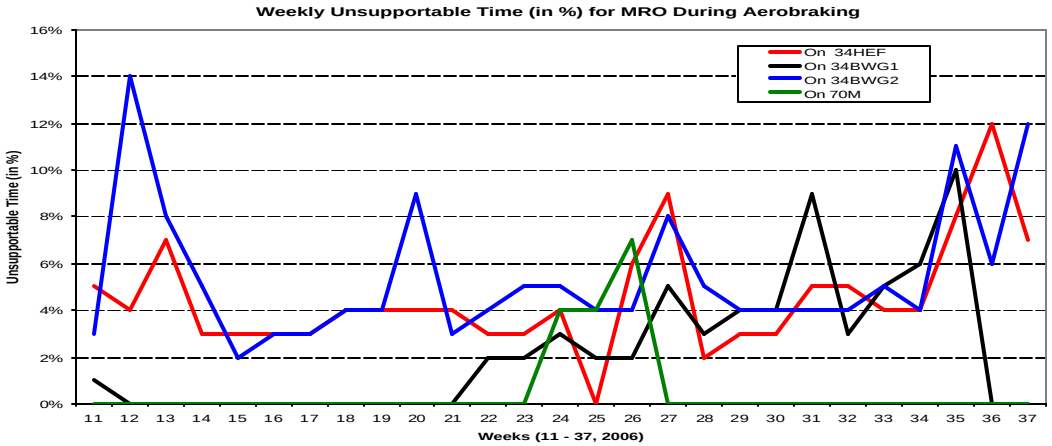


Figure 8

During the Aerobraking phase, MRO is above 90% supportable on an average except in week 12 on the 34BWG2 subnet and in weeks 36 and 37 on the 34HEF and 34BWG2 subnets where it is projected to lose about 14% of the requested time. Figure 8 shows the weekly unsupportable time for MRO during this phase. Since the unsupportable time during the above mentioned weeks is less than 15%, it is considered workable during the mid-range scheduling process.

Although MRO does not have significant unsupportable time during this phase, it is important to see how other Mars missions like MGS, MEX and M01O who share the same view period are affected by MRO during this time frame.

MGS is requesting for 24 hours continuous downlink during this period. It requests most of its support on the 34-meter subnet but MSPA's to the maximum extent with M01O and MEX on the 70M whenever possible. The remaining supports are scheduled on the 34-meter subnet and are in contention with MRO requirements. If MRO agrees to MSPA during this time with MGS, supportability for MGS will be increased greatly.

Figure 9 shows the difference in supportability for MGS mission when it uses the MSPA capability with MRO to when it does not. It is important to note that supportable time for MGS would increase from an average of 75% to 87% if it is allowed to MSPA with MRO during the Aerobraking phase considering that MGS will MSPA nearly 100% with MRO during this period.

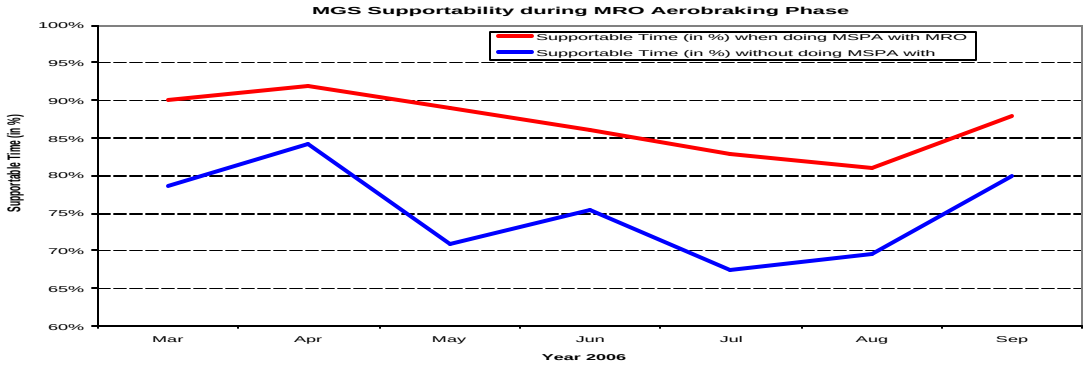


Figure 9

M01O and MEX request most of their supports on the 70M and MSPA to a maximum extent within themselves and with MGS. MRO requirements on 34-meter do not affect M01O and MEX much but if M01O and MEX agree to move to 34-meter especially when DSS-63 is down and MSPA with MRO, contention on the 70-meter subnet can be reduced to a significant extent.

Transition to Primary Science

During this phase, MRO is nearly 90% supportable in all weeks except in week 37 where it loses 14% of requested time on the 34HEF and 24% of requested time on the 34BWG2 subnet. Figure 10 shows the weekly unsupportable percentage of time for MRO during this period.

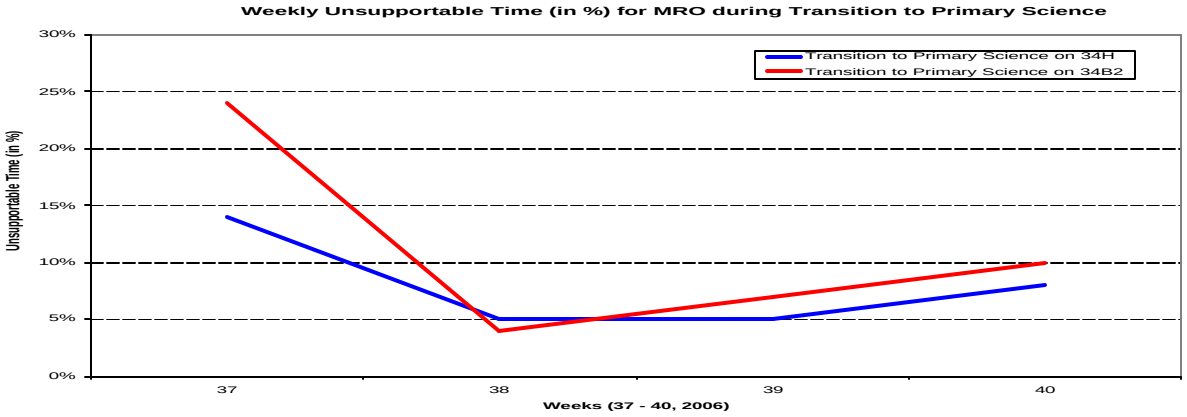


Figure 10

In week 37, MRO has contention with requirements supporting DSS routine maintenance, MGS mapping and MSPA with MEX orbital science and SOHO keyhole on the 34HEF subnet and with DSS routine maintenance, MESSENGER (MSGR) cruise, New Horizons (NHPC) Delta DOR (DDOR), Rosetta (ROSE) Mars Swing-by and STA prime science on the 34BWG2 subnet. Contention at Goldstone (GDS) is further compounded by DSS-24 downtime.

Figure 11 shows the view periods overlap of MRO with the previously mentioned missions. MRO, MGS and MEX use the MAR6 view period which is shown in "Red" below. Since MRO is already showing 14% loss on the 34HEF subnet, moving some of the supports from 34BWG2 to HEF especially from DSS-25, 26 to DSS-15 will not be helpful. Therefore if MSGR, ROSE and STA reduce some of their support in this week, MRO can have a slight increase in supportability on the 34BWG2 subnet.

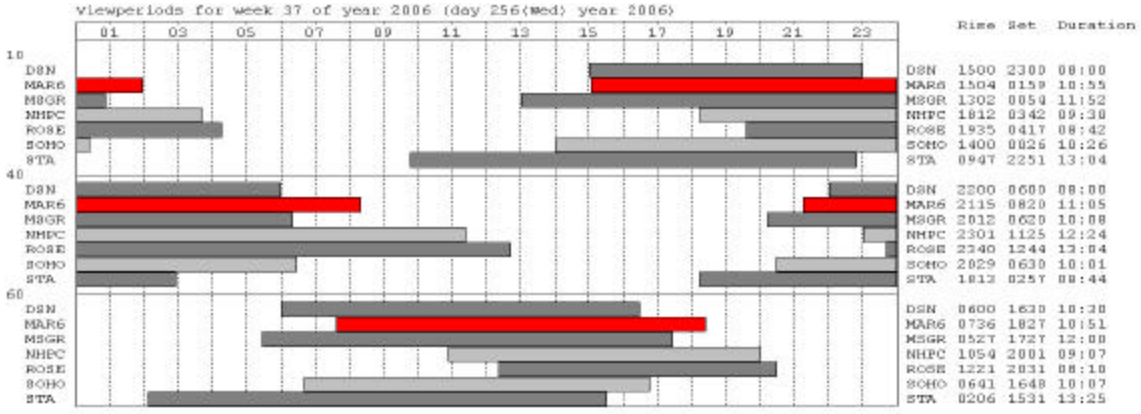


Figure 11

Solar Conjunction Break

During the solar conjunction break, MRO is above 85% supportable in all weeks except in week 40 where it loses 20% of the requested time on the 34HEF subnet and in week 41 where it loses 27% of the requested time on the 34BWG1 subnet. Figure 12 shows the weekly unsupportable percentage of time for MRO during this period.

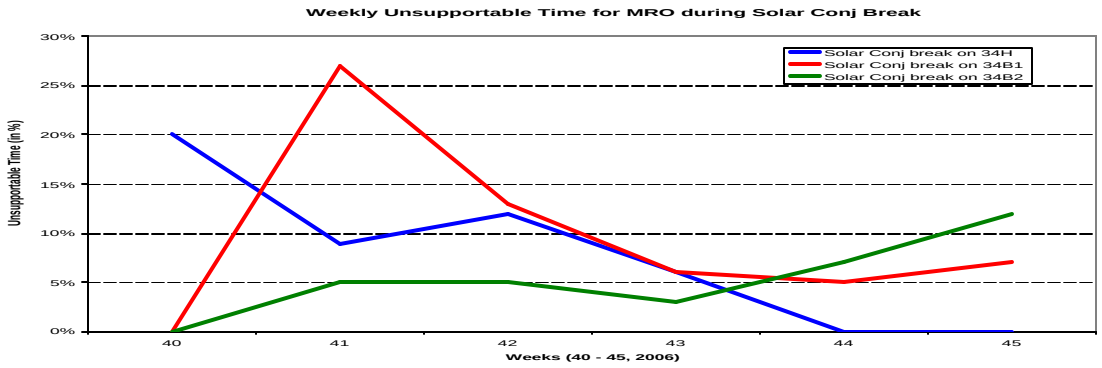


Figure 12

In week 40, it has contention with requirements supporting DSS routine maintenance, MSGR DDOR, MGS Mapping MSPA with M01O Mapping and Venus Express (VEX) Solar Conjunction on the 34HEF subnet. Contention is mainly at GDS and is further compounded by DSS-24 downtime. Moving some of MRO supports from DSS-15 to DSS-25, 26 will not be helpful as they will be in contention with requirements supporting ROSE Mars swingby, MSGR cruise, STA and STB Prime Science. Figure 13 shows the view period overlap of MRO with the previously mentioned missions. The view period overlap in weeks 40 and 41 are nearly the same.

In week 41, it has contention with requirements supporting MSGR cruise, NHPC cruise, RFC X/Ka pass, ROSE cruise, STA prime science and STB prime science on the 34BWG1 subnet. During this week contention is mainly at GDS and Canberra (CAN) due to DSS-45 and DSS-24 downtime. Moving some of MRO supports from 34 HEF and 34BWG1 to 34BWG2 may not be helpful as it will be in contention with ROSE Cruise, STA prime science, STB prime science and MSGR cruise at DSS-25, 26 when DSS-24 is down for maintenance.

Figure 13 shows the view period overlap of MRO with the previously mentioned missions.

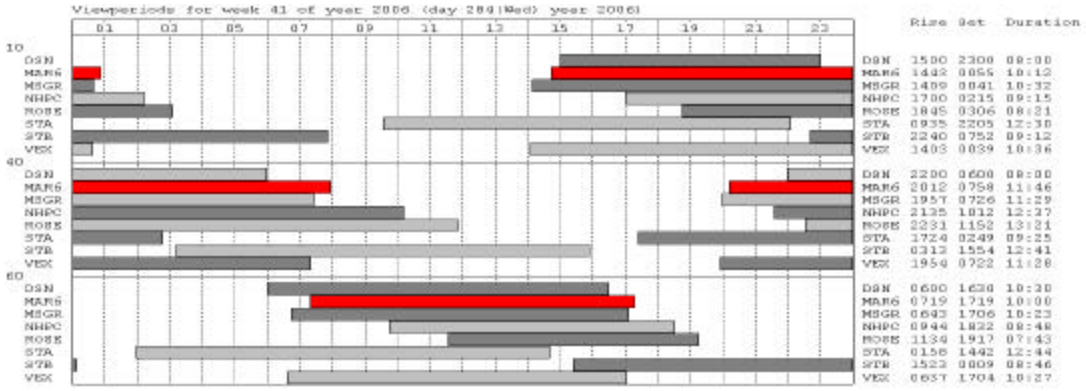


Figure 13

Primary Science Phase

In the Primary Science Phase, MRO requires all requested tracks time on 34-meter stations to be above 20-degree elevation to enable MRO to meet data volume requirements. The 20-degree elevation mask does not apply to 70M station coverage. As per the preferences stated in the document (MRO_IOM_RARB_inputs_10-04.doc), 34-meter BWG stations are preferred over 34-meter HEF stations and unless requested specifically for Ka-band support, it is generally acceptable to substitute a 70m station for a 34m station.

Figure 14 and 15 show the weekly unsupportable percentage of time on the 34BWG1, 34BWG2 and 70M, 34HEF subnets respectively during the entire Prime Science phase.

On an average MRO is above 90% supportable in years 2006 through 2008 except in weeks 38, 40 and 46 of 2008 on the 34BWG1 subnet, in weeks 01 through 09 of 2007 and weeks 41 and 47 of 2008 on the 70M subnet where the unsupportable time is greater than 15%. All unsupportable time below 15%, is considered workable during the mid-range scheduling process.

Contention is concentrated in the early part of 2007 and the later part of 2008. These periods are analyzed in detail.

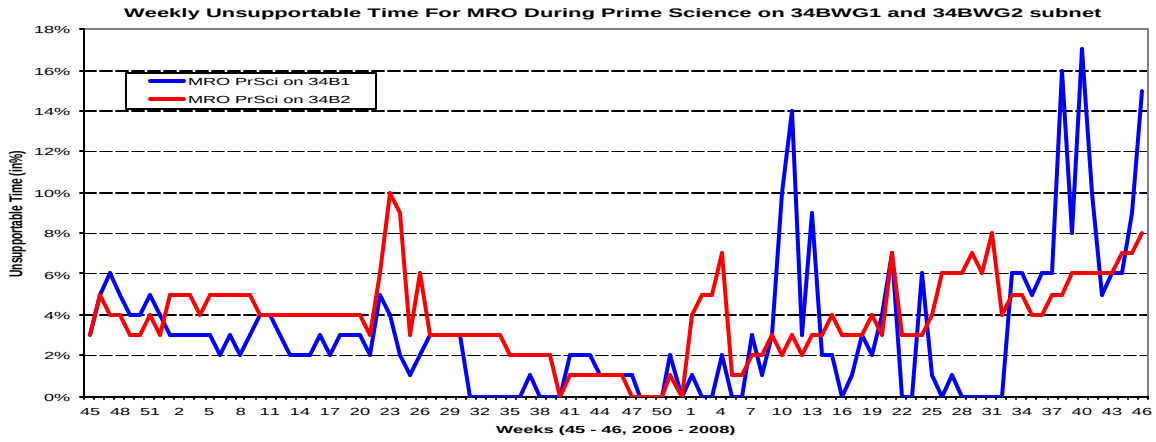


Figure 14

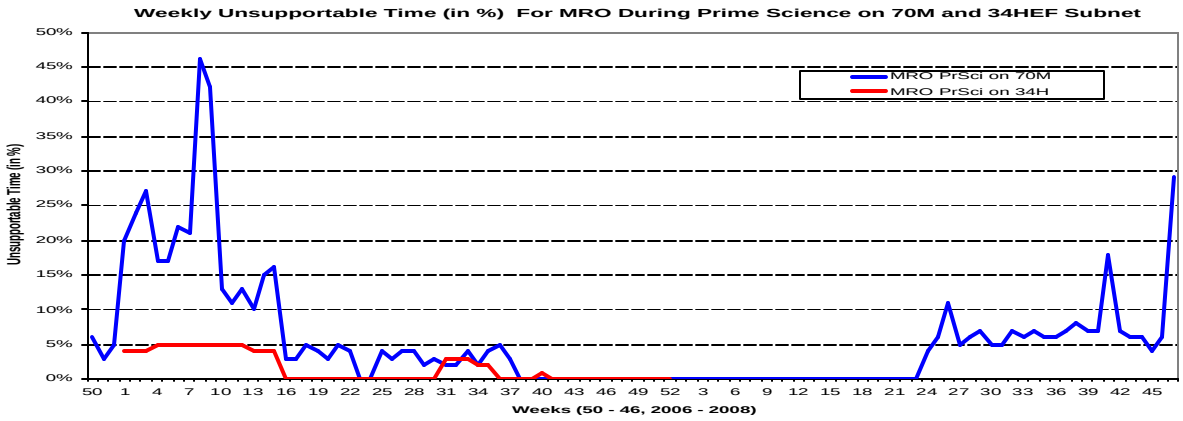


Figure 15

The 20-degree elevation mask is depicted as MR20 and 6-degree elevation mask is depicted as MAR6 in the view period chart in Figure 16. There is no overlap between CAN and MAD using MR20 view period as shown below.

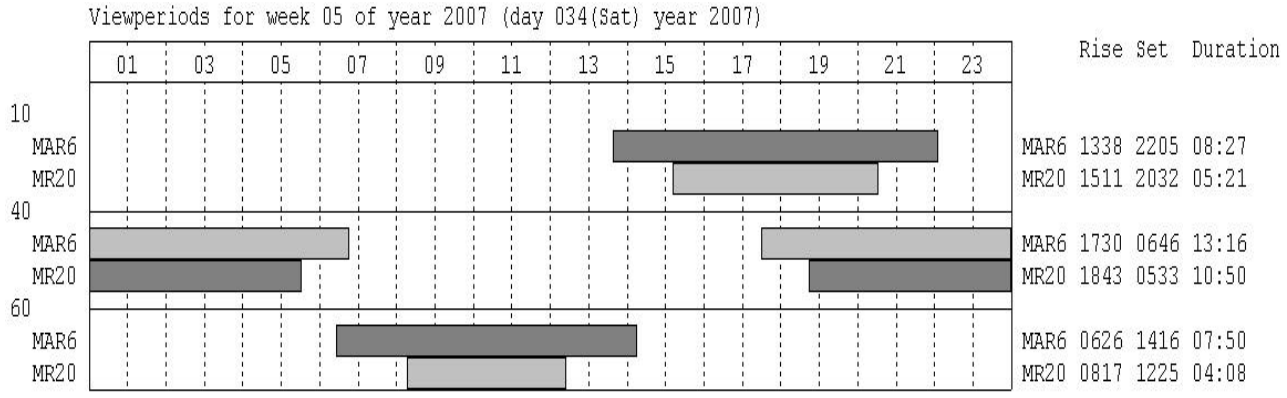


Figure 16

2007

In 2007, MRO is requesting 8-hour passes on the 34BWG antennas using 20-degree elevation mask for the Prime Science Phase. It does not have enough view period at GDS and MAD to support the request on the 34BWG antennas in weeks 01-15 as shown in Figure 16 above. Hence all the GDS and MAD passes have to be moved to the 70M and use the MAR6 view period. This results in high contention at the 70M.

Figure 17 shows the unsupportable time on the 70M during this period.

At the 70M, MRO is in contention with requirements supporting CLU2 SSO in weeks 5 -15, DSS Bearing and Routine Maintenance, EGS Global VLBI in week 7 and EGS EVN J-M4 in week 8, GSSR Asteroid 1991 VK in weeks 2 and 3, M01O Mapping, M01O Mapping and MSPA with MGS Mapping, NHPC Jupiter Approach in weeks 01- 07, NHPC Jupiter Flyby in weeks 7 and 8, NHPC Maneuver in weeks 6, 8, 11 and 13 and NHPC Jupiter Depart in weeks 10 -18, SOHO Keyhole in weeks 8,9 and 10, ROSE Mars Swing-by in weeks 01-08 and STA Prime Science and STB Prime Science in weeks 14-15.

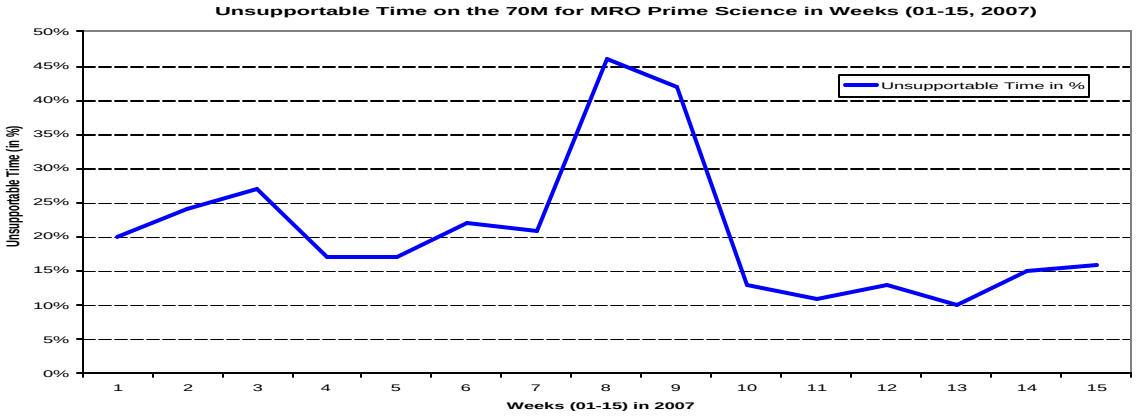


Figure 17

A sample of the view period overlap of MRO with the above mentioned missions during this period are shown in Figure 18. EGS uses 24-hour view, so it is not shown in the view period overlap chart. It requests 24-hour support for Global VLBI and 16-hour support for EVN J-M4 activity.

In order to reduce contention at the 70M in weeks 07 – 09 and to fulfill MRO requirements:

MRO maximize the 34-meter coverage at CAN and use a mix of 70M, 34BWG1 and 34BWG2 combination at GDS and MAD.
EGS must delete its support in week 08
GSSR Mercury must delete its support in weeks 07 and 08
DSS Maintenance must delete 1 of 2 routine maintenance supports at DSS-14 in week 08
ATOT must move its A01 astrometry support from week 07 to week 02.
M01O must move its standalone supports to DSS-43, MSPA with MRO to the maximum extent at GDS and MAD and move the remaining supports to 34-meter subnet and MSPA with MGS.

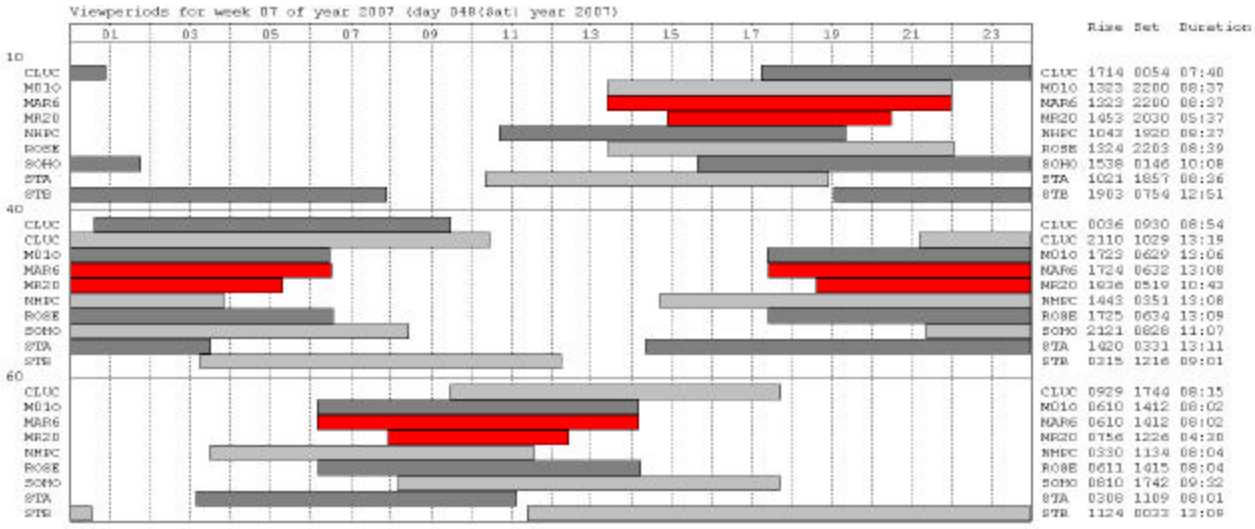


Figure 18

2008

In week 38, MRO has contention with requirements supporting DSS maintenance, Kepler (KEPL) quarterly roll and science operations, MSGR cruise and ROSE asteroid flyby; in week 40 it has contention with KEPL science operations, MSGR cruise and RFC CAT X/Ka and X/Ka pass, in week 46 it has contention with requirements supporting NHPC beacon in addition to MSGR cruise and RFC CAT X/Ka requirements on the 34BWG1 subnet.

In weeks 41 and 47, MRO has contention with requirements supporting DSS routine maintenance, Ground Based Radio Astronomy (GBRA) Guest observation and PRA-GAVRT, M01O Relay, MSGR mercury Flyby2, NHPC checkout and PHX Surface Ops on the 70M.

The view period overlap between MRO and the above mentioned missions are shown in Figure 19. MRO uses the 20-degree elevation mask (MARS) view period during prime science phase and is shown in “Red”. MRO can have increased supportability during this period if it agrees to MSPA with PHX on the 70M. GBRA will have to reduce its support at DSS-14 to accommodate MRO.

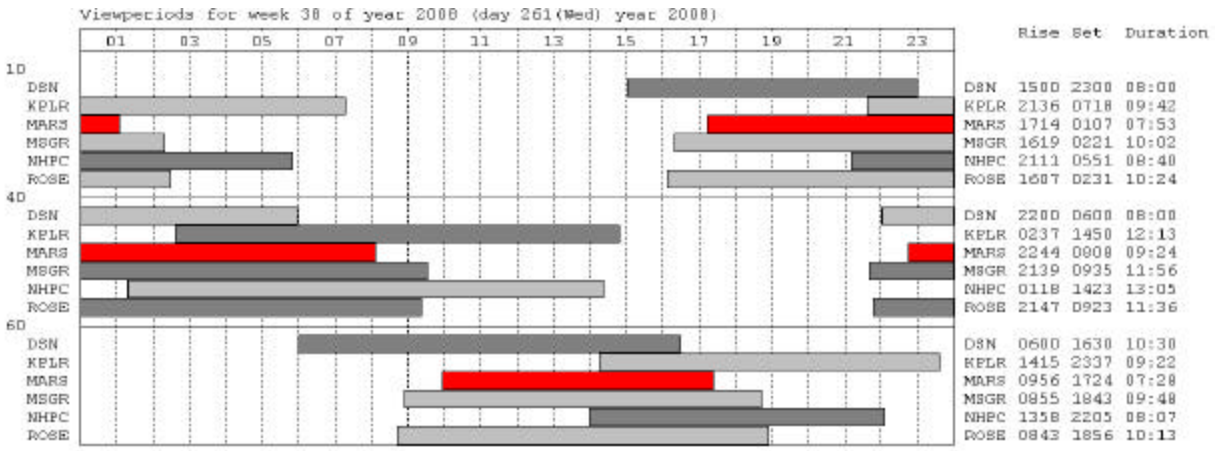


Figure 19

MRO Ka-band Ops Demo

MRO has less than 15% unsupportable time throughout the Ka-band Ops demonstration period as shown in Figure 20 below and is considered workable during the Midrange scheduling process.

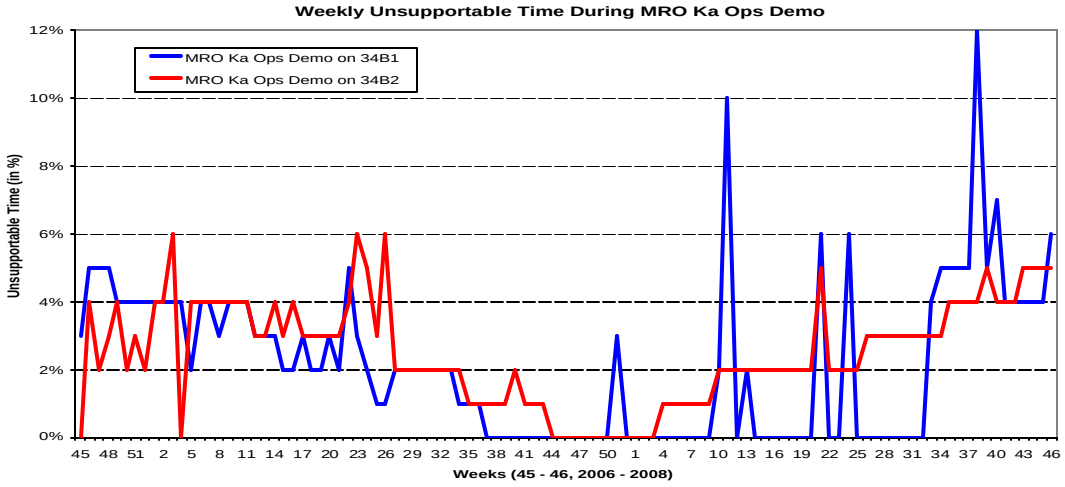


Figure 20

70M Science Augmentation

For the 70M science augmentation, MRO requests 3 passes per week in addition to primary science tracking on the 70M and the supportability for this period has already been analyzed under the primary science phase on the 70M subnet as shown in Figure 15.

Relay Phase

MRO has less than 10% unsupportable time in all the weeks of year 2009 and 2010 except in weeks 44-47 of 2009; weeks 03, 09-12 and weeks 33 - 41 of 2010 on the 34BWG1 subnet. No downtimes are planned for these years as yet. These periods of contention are further analyzed as below.

Figure 21 shows the weekly unsupportable time (in %) for MRO during the Relay phase.

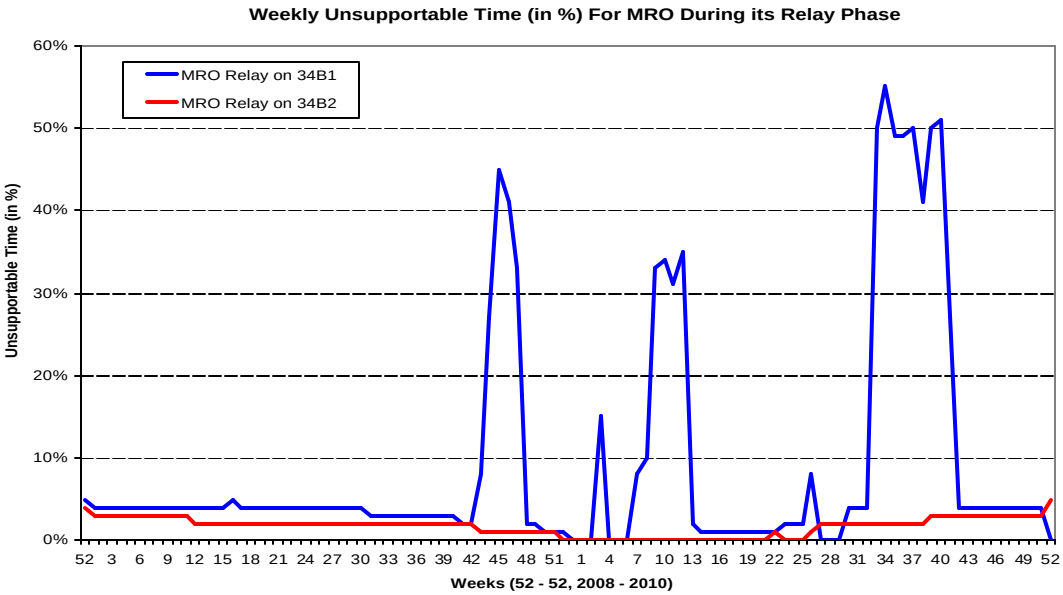


Figure 21

2009

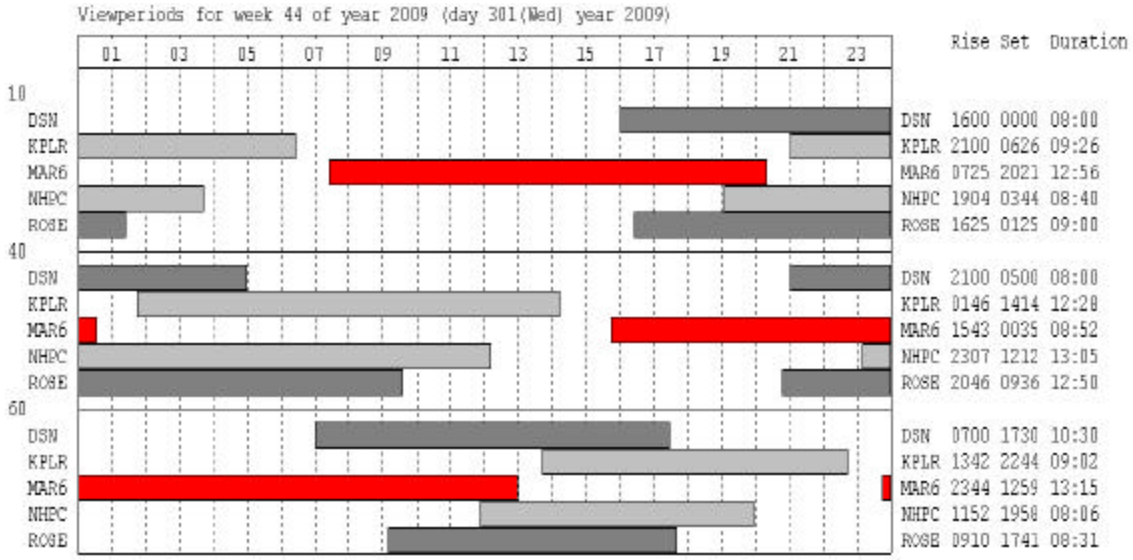


Figure 22

In weeks 44-47 of 2009, MRO has contention with requirements supporting DSS routine maintenance, Mars Science Laboratory 2009 (MSL) launch, KEPL science Operations, NHPC beacon, ROSE earth swing-by and the 24-hour dual supports for RFC CAT X/Ka supports in weeks 46 and 47 at DSS-26 and DSS-34. Figure 22 shows the view period overlap of MRO with the previously mentioned missions. MRO and MSL use the MAR6 view period and this is highlighted in Figure 22 in "Red." During this period supportability for MRO can be increased if MSL moves some of their launch support from 34BWG1 to 34HEF and 34BWG2 subnets and if DSS maintenance either reduce their support or delete some of their supports during this period to accommodate MRO.

2010

In week 03, MRO has contention with requirements supporting MSL cruise and TCM and the 24-hour dual supports for RFC CAT X/Ka on the 34BWG1 subnet. MRO can have increased supportability during this period if it negotiates with MSL to move some of their support from 34BWG1 to 34HEF and 34BWG2 subnets.

In weeks 09 through 12, MRO has contention with requirements supporting DSS routine maintenance, SIM launch, MSL cruise, and the 24-hour dual supports for RFC CAT X/Ka. MRO can have increased supportability during this period, if MRO moves some of its support from 34BWG1 to 70M, 34BWG2 subnet and also if RFC reduces its support. MRO has to accommodate DSS maintenance especially at CAN. MRO cannot move its support to 34HEF subnet during this period, as it will be in contention with Mars Telecom Orbiter 2009 (MTO) approach requirements.

Figure 23 shows the view period overlap of MRO with the previously mentioned missions. MRO uses the MAR6 view period and is shown in "red". SIM uses ET06 (earth trailing orbit with 6-degrees mask) as view period object.

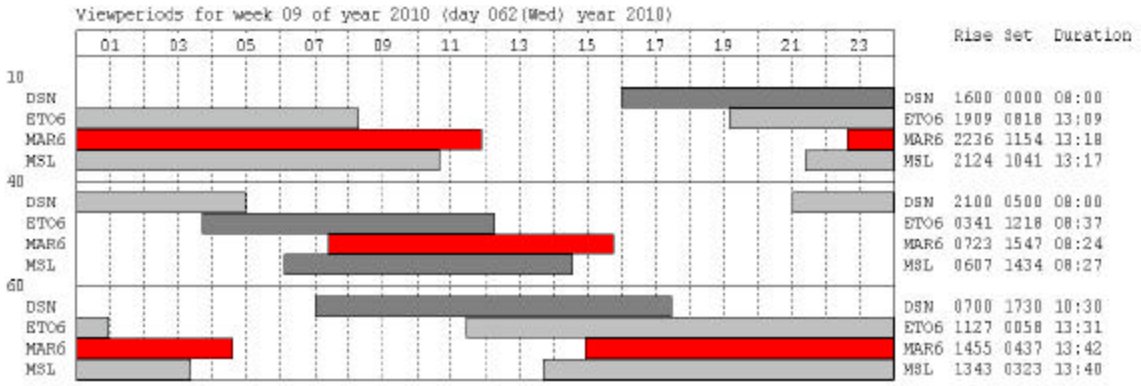


Figure 23

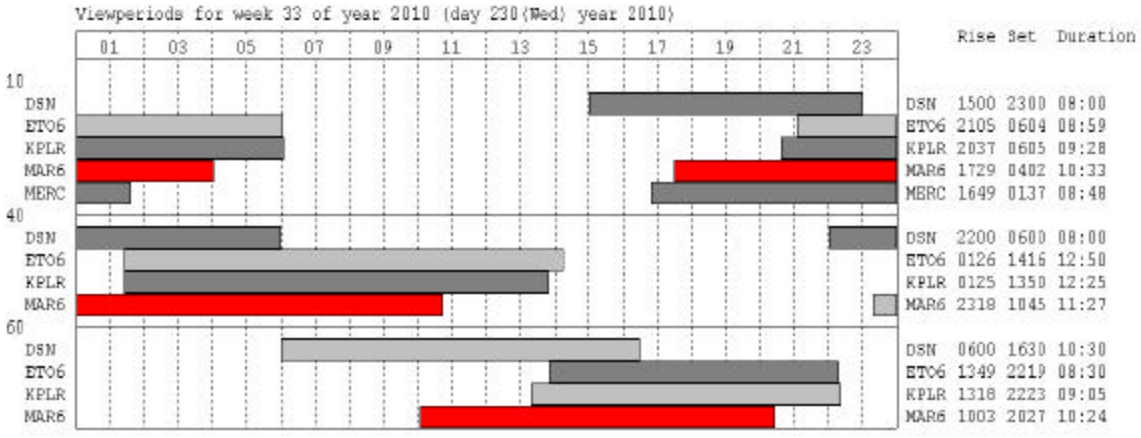


Figure 24

In weeks 33 through 41, MRO has contention with requirements supporting DSS routine maintenance and calibrations, KEPL science operations and quarterly roll, MSL approach and surface operations, MSGR cruise, 24-hour dual support for RFC Cat X/Ka and X/Ka pass and SIM operations on the

34BWG1 subnet. Figure 24 shows the view period overlap of MRO with the previously mentioned missions. MSGR uses MERC, SIM uses ET06, KEPL uses KPLR and MRO and MSL use MAR6 as view period objects respectively.

MRO cannot move its support to 34HEF subnet as it will be in contention with requirements supporting MTO approach and relay, RFC CAT S/X and SGP crusted dynamics. MRO cannot move its support to 34BWG2 subnet as it will be in contention with requirements supporting KEPL science operations, MSL approach and TCM, MSGR cruise and 24-hour dual requirement for RFC CAT X/Ka. MRO can get increased supportability during this period if MTO agrees to MSPA with MRO and if RFC either reduces its support or move its support to another week to accommodate MRO. MRO also has to accommodate DSS maintenance during this period.

Conclusion

Overall Mars Reconnaissance Orbiter should receive above 90% of the requested time during its prime mission. In 2006, there are periods where MRO may have to negotiate with other missions like STA, STB, MSGR and other Mars missions especially when DSS-24 and DSS-45 are down for maintenance. In 2007, MRO has limited view at GDS and MAD on the 34BWG stations using the 20-degree elevation mask. Hence it has to move most of its Prime Science passes to the 70M in weeks 01 through 15 and use the 6-degree elevation mask. This causes an increased contention on the 70M especially when NHPC is requesting coverage on the 70M for its Jupiter Flyby. MRO has to MSPA to the maximum extent with M01O and negotiate with NHPC to reduce contention on the 70M subnet during this period. In 2008, there is contention with other Mars missions during Phoenix Surface Operations. In 2009 and 2010 there are periods where the unsupportable percentage of time for MRO is significant due to several missions like MTO and MSL sharing the same view period. MRO can get increased supportability if it agrees to MSPA with MTO during this period.

As always, the results of this study are preliminary in that network loading changes as requirements for planned missions are input and updated. We will continue to work with Mars Reconnaissance Orbiter and other users of the DSN to maximize the time available for each individual user.

cc:
A. Andujo
E. Hampton
N. Lacey
D. Morris
J. Retana

Supporting Data

Mars Reconnaissance Orbiter - DSN Tracking Requirements

Mission Phase	Launch Relative Start Date	Start Date	End Date	DOY	Required DSN Resource	Required tracking	Comments
Launch	L + 000 days	10-Aug-05	10-Aug-05	222	34m, 26m +	Continuous	Period closes 8/30/05, Initial Acq @Goldstone or Canberra
TCM 1	L + 015 days	25-Aug-05	25-Aug-05	237	34m	Continuous	
HGA Cal	L + 024 days	3-Sep-05	3-Sep-05	246	34m*	Continuous	Needs X/X/Ka during Cal
Mars Cruise	L + 030 days	9-Sep-05	9-Jan-06	252	34m	1 pass/day	standard cruise, 8 hour passes, include 1 Ka capable station per week
Delta-DOR	L + 041 days	20-Sep-05	29-Jan-06	263	34m	1 pass/week	2-antenna at overlap, additional to continuous coverage; 1/week until MOI-40 days; alternate East/West and North/South overlaps, Prefer 34m BWG stations to get X and Ka DDOR - need 10 Ka DDORs
TCM 2	L + 087 days	5-Nov-05	11-Nov-05	309	34m	Continuous	TCM coverage, +/- 3 days around L+90, dual track for the burn event.
Calibration	L + 138 days	26-Dec-05	2-Jan-06	360	34m	Continuous	7 days; Continuous 34m support for calibrations. Need DDOR on 1st, 4th and 7th days,both baselines.
Mars Approach	M - 060 days	9-Jan-06	10-Mar-06	9	34m	Continuous	Begin arrival preparations
TCM 3	M - 040 days	29-Jan-06	29-Jan-06	29	34m	Continuous	TCM coverage, dual track for the burn event.
Delta-DOR	M - 040 days	29-Jan-06	5-Mar-06	29	34m	2 pass/week	2-antenna at overlap, additional to continuous coverage; 2/week until MOI-5 days; alternate East/West and North/South overlaps
TCM 4	M - 010 days	28-Feb-06	28-Feb-06	59	34m	Continuous	Dual track for the burn event.
TCM 5	M - 001 days	9-Mar-06	9-Mar-06	68	34m	Continuous	Only if needed. 5A at M-24 hrs or 5B at M-6 hrs. Dual track for the burn event.
Mars Orbit Insertion (MOI)	M + 000 days	10-Mar-06	10-Mar-06	69	70m	Continuous	Dual 70m tracks at overlap
Aerobraking	M + 007 days	17-Mar-06	15-Sep-06	76	34m	Continuous	
End Aerobraking (ABX),Transition to Primary Science	M + 189 days	15-Sep-06	7-Oct-06	258	34m	2 pass/day	Reconfigure S/C
Solar Conjunction Break	M + 211 days	7-Oct-06	8-Nov-06	280	34m*	2 pass/day	Ka-band capable stations. Reduced S/C operations
Primary Science Phase	M + 243 days	8-Nov-06	18-Nov-08	312	34m*	2 pass/day	34m BWG stations, 20 deg elevation constraint
Ka-band Demonstration	M + 243 days	8-Nov-06	18-Nov-08	312	34m*	2 pass/week	In addition to Primary Science Tracking
70m Science Augmentation #1	M + 243 days	8-Nov-06	11-Sep-07	312	70m	3 pass/week	In addition to Primary Science Tracking; Stops 9/11/07
70m Science Augmentation #2	M + 826 days	13-Jun-08	18-Nov-08	165	70m	3 pass/week	In addition to Primary Science Tracking; Until end of phase (18-Nov-08)
Relay Phase	M + 984 days	18-Nov-08	31-Dec-10	323	34m*	1 pass/day	Ka capable 34m BWG stations
Solar Conjunction Break	M + 984 days	18-Nov-08	16-Dec-08	323	34m*	1 pass/day	Ka-band capable stations. Minimal S/C operations
Extended Mission	M + 1758 days	1-Jan-11	31-Dec-10	366	34m*	1 pass/day	Ka capable 34m BWG stations

Notes:

- type-1 trajectory
- launched on Atlas V vehicle
- launch period is August 10 - August 30, 2005
- arrival at Mars is March 10 to March 16, 2006
- 34m* = require BWG stations 5 of 7 passes - weekly
- TCM = Trajectory Correction Maneuver
- L+ = launch plus
- M+/- = MOI +/-
- Dual track means to schedule two stations at the same time

User Loading Profiles

Concurrence: _____

Project Manager Date

MRO

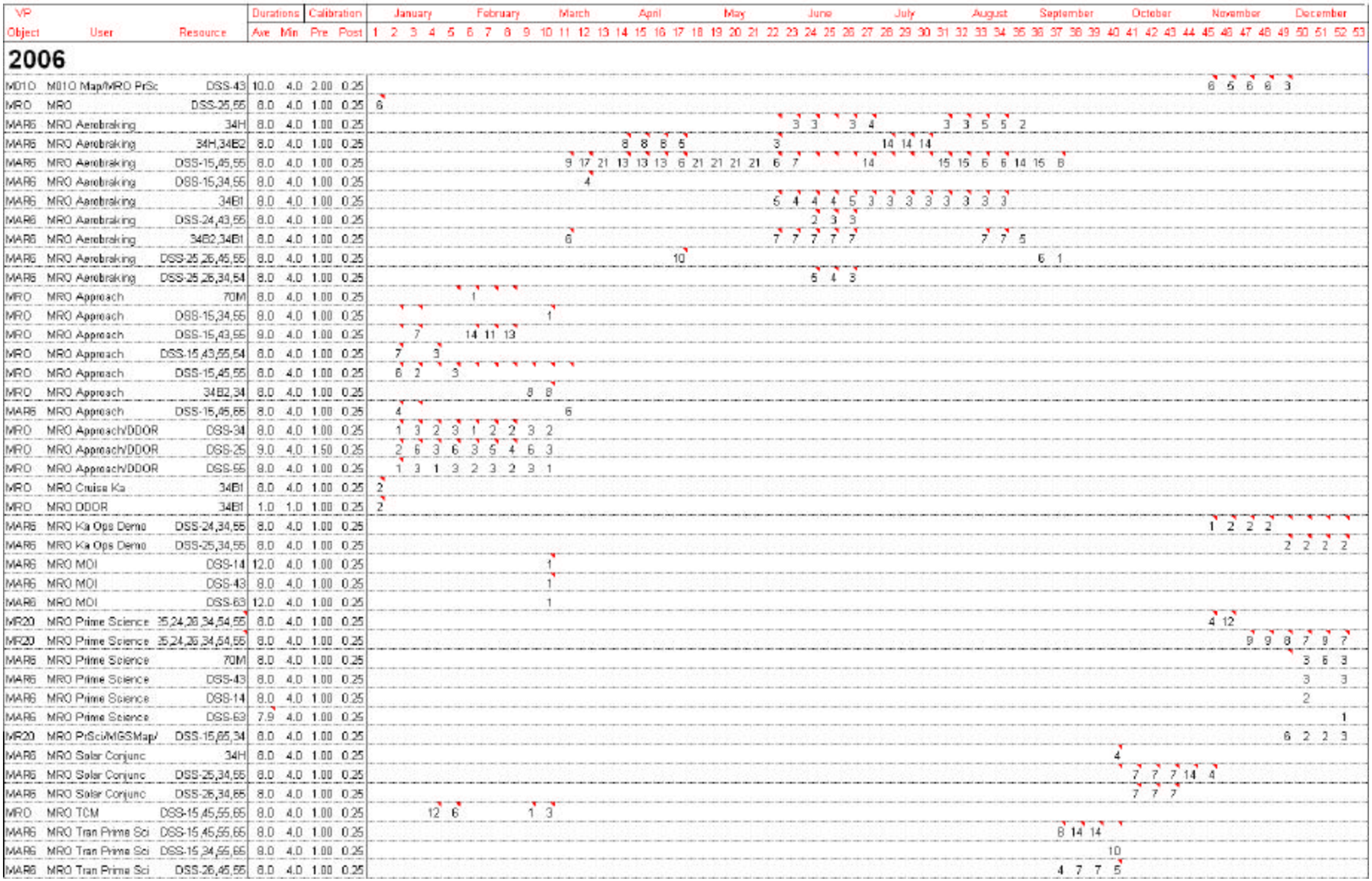
VP Object	User	Resource	Durations Ave	Min	Calibration Pre	Post	January 1 2 3 4 5	February 6 7 8 9	March 10 11 12 13 14	April 15 16 17 18 19	May 20 21 22 23 24	June 25 26 27 28 29	July 30 31 32 33	August 34 35 36	September 37 38 39 40	October 41 42 43 44	November 45 46 47 48	December 49 50 51 52 53
2005																		
MRO	MRO	34H	8.0	4.0	1.00	0.25								2	6 5 4		6	6 6 6 6 2
MRO	MRO	DSS-15,45	8.0	4.0	1.00	0.25											6	
MRO	MRO	34B1	8.0	4.0	1.00	0.25												2
MRO	MRO	DSS-25,45,65	8.0	4.0	1.00	0.25									6	6 6 6		
MRO	MRO	DSS-26,34,55	8.0	4.0	1.00	0.25											4 2	
MRO	MRO	DSS-25,45	8.0	4.0	1.00	0.25											4	
MRO	MRO	DSS-25,34	8.0	4.0	1.00	0.25											2	
MRO	MRO	34B2	8.0	4.0	1.00	0.25												2
MRO	MRO Calibration	34H	8.0	4.0	1.00	0.25												8
MRO	MRO Calibration	34B1	8.0	4.0	1.00	0.25												2
MRO	MRO Cruise Ka	DSS-26,34,55	8.0	4.0	1.00	0.25								1	1 1 1 1 1 1 1 1		1 1 1 1 1 1	1
MRO	MRO Cruise Ka	DSS-26,55	8.0	4.0	1.00	0.25											1	
MRO	MRO DDOR	34B1	1.0	1.0	1.00	0.25									1 1 1 1 1 1 1	1 1 1 1 1 1 1		2
MRO	MRO DDOR	34B2	1.0	1.0	1.00	0.25												2
MRO	MRO Launch Supt	34H	8.0	4.0	1.00	0.25							12	21 18				
MRO	MRO Launch Supt	DSS-15,45,55	8.0	4.0	1.00	0.25								21	12			
MRO	MRO Launch Supt	DSS-55	16.0	4.0	1.00	0.25							1					
MROL	MRO LNCH/INIT ACQ	DSS-45/34/46	4.5	4.0	3.00	0.25							1					
MRO	MRO LNCH/INIT ACQ	DSS-15/24/16	4.5	4.0	3.00	0.25							1					
MRO	MRO TCM	34H	8.0	4.0	1.00	0.25								3				
MRO	MRO TCM	DSS-26,45,65	8.0	4.0	1.00	0.25										6 12		

User Loading Profiles

Concurrence:

Project Manager Date

MRO



VP Object	User	Resource	Durations Ave	Min	Calibration Pre	Post
2006						
M01O	M01O Map/MRO PrSc	DSS-43	10.0	4.0	2.00	0.25
MRO	MRO	DSS-25,65	8.0	4.0	1.00	0.25
MAR6	MRO Aerobraking	34H	8.0	4.0	1.00	0.25
MAR6	MRO Aerobraking	34H,34B2	8.0	4.0	1.00	0.25
MAR6	MRO Aerobraking	DSS-15,45,55	8.0	4.0	1.00	0.25
MAR6	MRO Aerobraking	DSS-15,34,55	8.0	4.0	1.00	0.25
MAR6	MRO Aerobraking	34B1	8.0	4.0	1.00	0.25
MAR6	MRO Aerobraking	DSS-24,43,65	8.0	4.0	1.00	0.25
MAR6	MRO Aerobraking	34B2,34B1	8.0	4.0	1.00	0.25
MAR6	MRO Aerobraking	DSS-25,26,45,55	8.0	4.0	1.00	0.25
MAR6	MRO Aerobraking	DSS-25,26,34,54	8.0	4.0	1.00	0.25
MRO	MRO Approach	70M	8.0	4.0	1.00	0.25
MRO	MRO Approach	DSS-15,34,55	8.0	4.0	1.00	0.25
MRO	MRO Approach	DSS-15,43,55	9.0	4.0	1.00	0.25
MRO	MRO Approach	DSS-15,43,55,54	8.0	4.0	1.00	0.25
MRO	MRO Approach	DSS-15,45,55	8.0	4.0	1.00	0.25
MRO	MRO Approach	34B2,34	8.0	4.0	1.00	0.25
MAR6	MRO Approach	DSS-15,45,65	8.0	4.0	1.00	0.25
MRO	MRO Approach/DDOR	DSS-34	8.0	4.0	1.00	0.25
MRO	MRO Approach/DDOR	DSS-25	9.0	4.0	1.50	0.25
MRO	MRO Approach/DDOR	DSS-55	8.0	4.0	1.00	0.25
MRO	MRO Cruise Ka	34B1	8.0	4.0	1.00	0.25
MRO	MRO DDOR	34B1	1.0	1.0	1.00	0.25
MAR6	MRO Ka Ops Demo	DSS-24,34,55	8.0	4.0	1.00	0.25
MAR6	MRO Ka Ops Demo	DSS-25,34,55	8.0	4.0	1.00	0.25
MAR6	MRO MOI	DSS-14	12.0	4.0	1.00	0.25
MAR6	MRO MOI	DSS-43	8.0	4.0	1.00	0.25
MAR6	MRO MOI	DSS-63	12.0	4.0	1.00	0.25
MR20	MRO Prime Science	35,24,26,34,54,55	8.0	4.0	1.00	0.25
MR20	MRO Prime Science	35,24,26,34,54,55	8.0	4.0	1.00	0.25
MAR6	MRO Prime Science	70M	8.0	4.0	1.00	0.25
MAR6	MRO Prime Science	DSS-43	8.0	4.0	1.00	0.25
MAR6	MRO Prime Science	DSS-14	8.0	4.0	1.00	0.25
MAR6	MRO Prime Science	DSS-63	7.9	4.0	1.00	0.25
MR20	MRO PrSci/MGSMap/	DSS-15,65,34	8.0	4.0	1.00	0.25
MAR6	MRO Solar Conjunc	34H	8.0	4.0	1.00	0.25
MAR6	MRO Solar Conjunc	DSS-25,34,55	8.0	4.0	1.00	0.25
MAR6	MRO Solar Conjunc	DSS-26,34,65	8.0	4.0	1.00	0.25
MRO	MRO TCM	DSS-15,45,55,65	8.0	4.0	1.00	0.25
MAR6	MRO Tran Prime Sci	DSS-15,45,55,65	8.0	4.0	1.00	0.25
MAR6	MRO Tran Prime Sci	DSS-15,34,55,65	8.0	4.0	1.00	0.25
MAR6	MRO Tran Prime Sci	DSS-26,45,55	8.0	4.0	1.00	0.25

User Loading Profiles

Concurrence:

Project Manager Date

MRO

VP Object	User	Resource	Durations Ave	Min	Calibration Pre	Post	January 1	2	3	4	5	February 6	7	8	9	March 10	11	12	13	14	April 15	16	17	18	May 19	20	21	22	June 23	24	25	26	July 27	28	29	30	31	August 32	33	34	35	September 36	37	38	39	October 40	41	42	43	November 44	45	46	47	48	December 49	50	51	52	53
2007																																																														
M01O	M01O Map/MRO PrSc	70M	8.0	4.0	1.00	0.25								2	2	2	2	2						2	2				3	3																																						
M01O	M01O Map/MRO PrSc	70M	10.0	4.0	1.00	0.25																																				7			7	7																					
MAR6	MRO Prime Science	70M	8.0	4.0	1.00	0.25																3	3	1	1	3	3	3			3	3	3	3	3	3	3	3	3	3	3	3	1																					
MAR6	MRO Prime Science	DSS-14,63	8.0	4.0	1.00	0.25																																																												
MAR6	MRO Prime Science	DSS-14	8.3	4.0	1.00	0.25	5	5	5	5	5	5	5	4																																																		
MAR6	MRO Prime Science	DSS-63	7.5	4.0	1.00	0.25	5	5	5	5	5	5	5	4																																																
MAR6	MRO Prime Science	DSS-14	8.0	4.0	1.00	0.25									4	4	4	4	4	4	4																																												
MAR6	MRO Prime Science	DSS-63	8.0	4.0	1.00	0.25									4	4	4	4	4	4	4																																											
MAR6	MRO PrSci/MEXOS	70M	8.0	4.0	1.00	0.25																																									7																					
MR20	MRO Prime Science	34H	8.0	4.0	1.00	0.25																																									7																					
MARS	MRO Ka Ops Demo	DSS-24,34,55	8.0	4.0	1.00	0.25																																																									
MR20	MRO Prime Science	34B1,34B2	8.0	4.0	1.00	0.25																10	10	14	14	14	14	14	11	11	11	11	14	14	14	14								14					14	14	14	7	7	7	7	7	14	14	14	14		
MR20	MRO Prime Science	DSS-24,54	8.0	4.0	1.00	0.25																																																									
MR20	MRO Prime Science	DSS-34,45	8.0	4.0	1.00	0.25	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7																																											
MR20	MRO Ka Ops Demo	DSS-26,55	4.0	4.0	1.00	0.25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4																																											
MARS	MRO Ka Ops Demo	DSS-25,34,55	8.0	4.0	1.00	0.25																2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
MR20	MRO Prime Science	34B2,34H	8.0	4.0	1.00	0.25																																																										
MR20	MRO Prime Science	34B2	8.0	4.0	1.00	0.25																																																									
MR20	MRO PrSci/MGSMap	DSS-25,26,55	8.0	4.0	1.00	0.25																																																								
MR20	MRO PrSci/MGSMap	DSS-25,26,54,55	8.0	4.0	1.00	0.25																4	4																																								
MR20	MRO PrSci/MGSMap	DSS-25,26,55	10.0	4.0	1.00	0.25																							3	3	3	3																																
MR20	MRO PrSci/MGSMap	34B2	8.0	4.0	1.00	0.25																																		3	3																						

User Loading Profiles

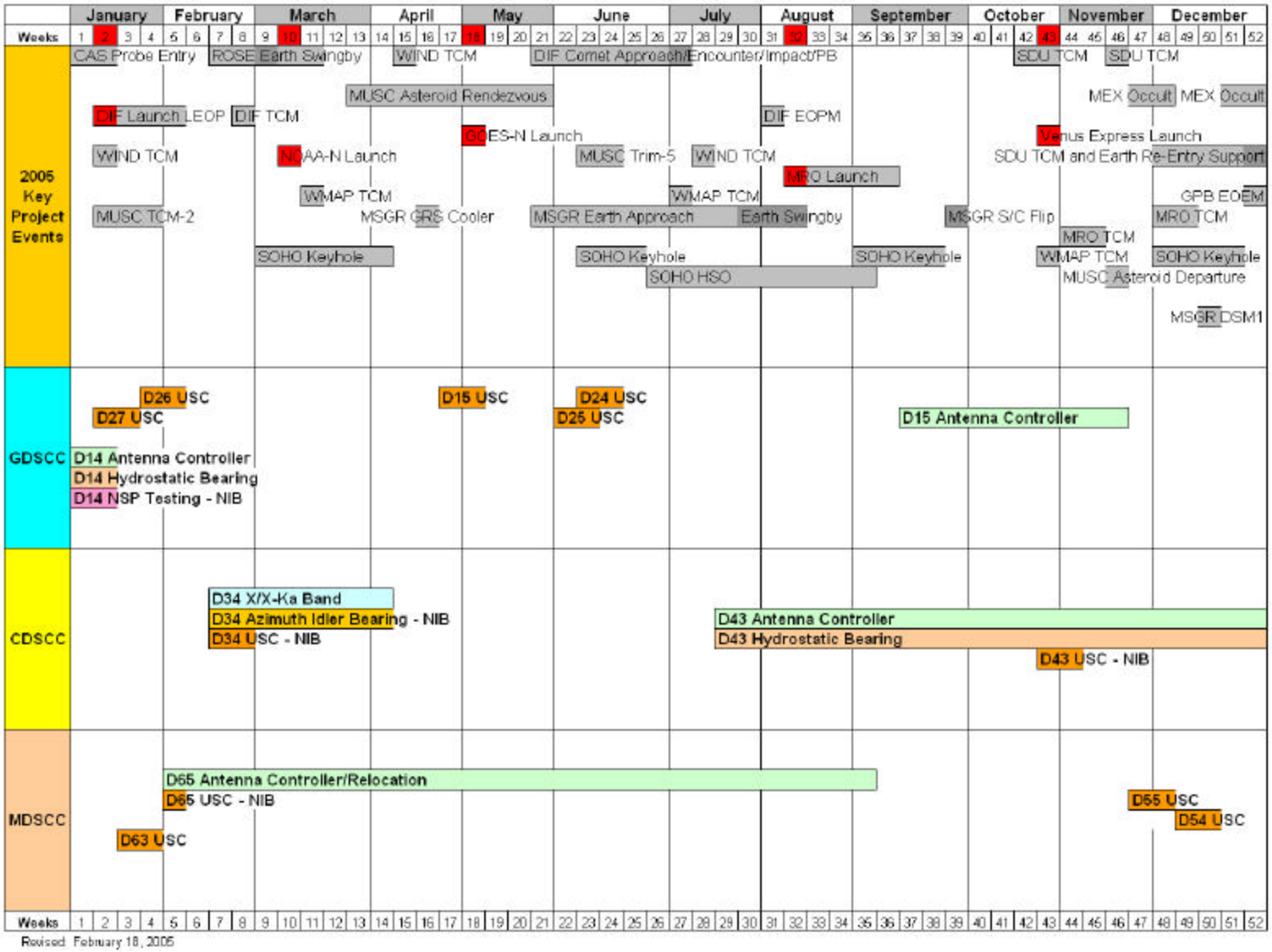
Concurrence: _____

Project Manager Date

MRO

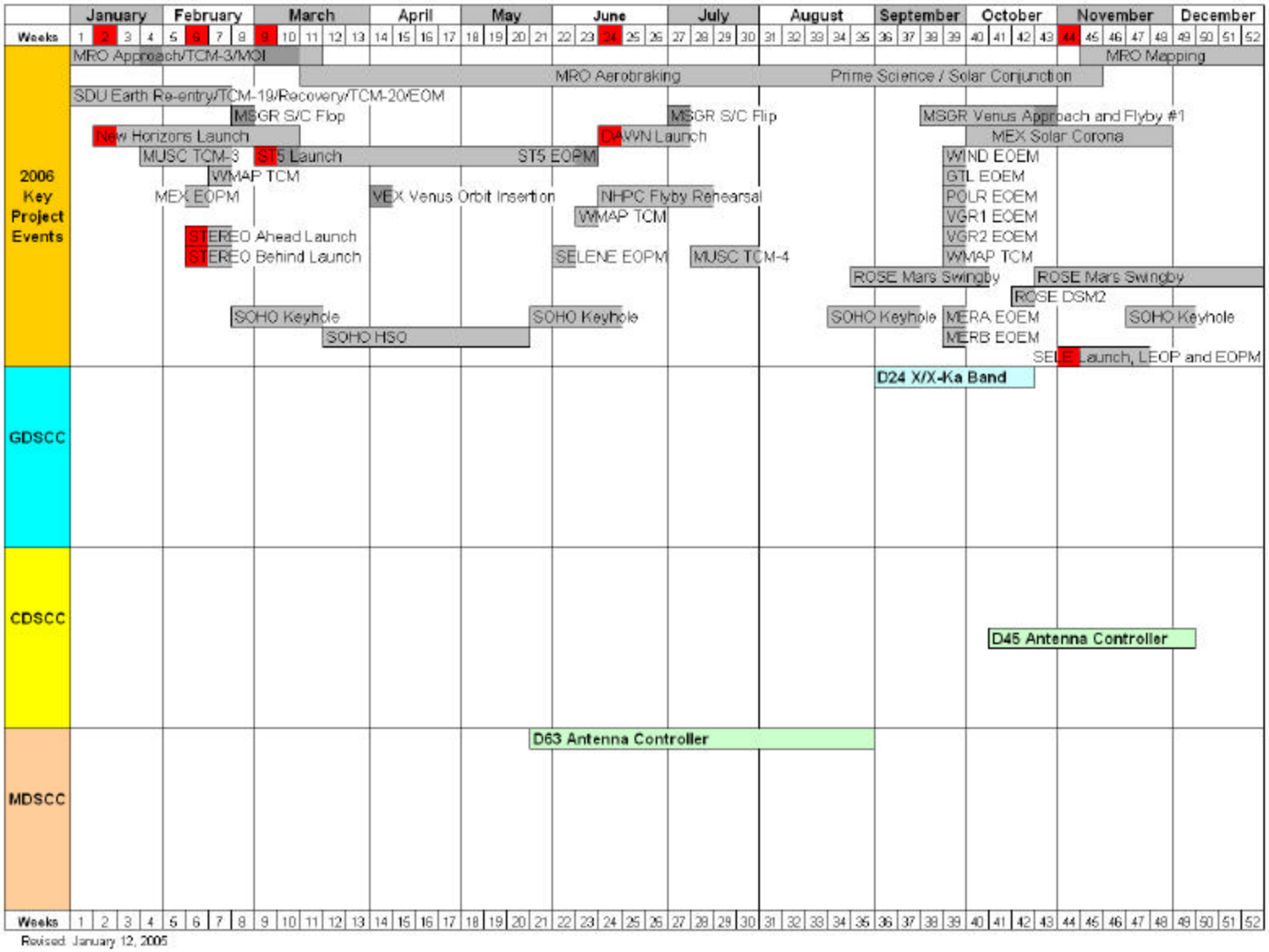
VP Object	User	Resource	Durations Ave	Min	Calibration Pre	Post	January 1	2	3	4	5	February 6	7	8	9	10	March 11	12	13	14	15	April 16	17	18	19	20	May 21	22	23	24	June 25	26	27	28	July 29	30	31	32	August 33	34	35	36	September 37	38	39	40	October 41	42	43	44	November 45	46	47	48	December 49	50	51	52	53
2008																																																																					
MR20	MRO Ka Ops Demo	DSS-25,34,55	8.0	4.0	1.00	0.25	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2									
MAR6	MRO Prime Science	70M	8.0	4.0	1.00	0.25																										3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1									
MR20	MRO Prime Science	DSS-25,34,55	8.0	4.0	1.00	0.25	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14									
MAR6	MRO Relay	DSS-25,34,55	8.0	4.0	1.00	0.25																																																													5				
MAR6	MRO Solar Conjunc	DSS-25,34,55	8.0	4.0	1.00	0.25																																																										6	7	7	7	7	2		
2009																																																																											
MAR6	MRO Relay	DSS-25,34,55	8.0	4.0	1.00	0.25	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
2010																																																																					
MAR6	MRO Relay	DSS-24,34,55	8.0	4.0	1.00	0.25	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7																															
MAR6	MRO Network Relay	DSS-25,34,55	8.0	4.0	1.00	0.25																																																													2		
MAR6	MRO Relay	DSS-25,34,55	8.0	4.0	1.00	0.25																														7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	5		

MAJOR DSN ANTENNA DOWNTIMES 2005



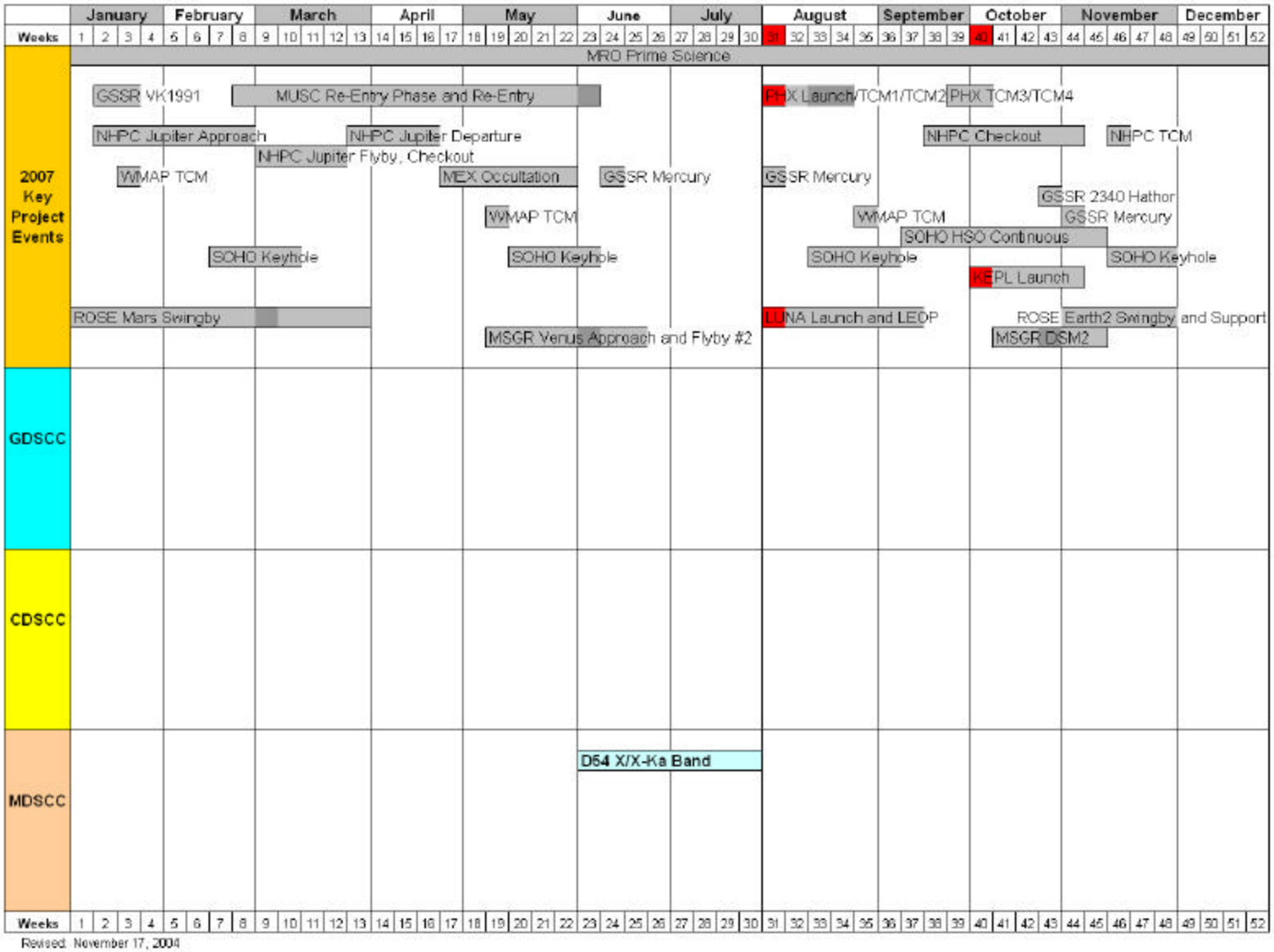
Revised: February 18, 2005

MAJOR DSN ANTENNA DOWNTIMES 2006



Revised January 12, 2005

MAJOR DSN ANTENNA DOWNTIMES 2007



Revised: November 17, 2004